F1

Introduction

Equation (III
1) in Chapter III of the main text enables calculation of the fix accuracy (2 drms) in terms of the bearings from the user to the master and two secondary stations, the common standard deviation of each TD, the correlation coefficient between the two TDs, and the gradient of the LOPs along the baseline.

To recapitulate, 2 drms is the radius of the fix area with probability content of at least 95%. That is, at the given point in the coverage area, at least 95% of the apparent fixes would be within a circular area of radius 2 drms. It is given by the equation:

```
                 2 K s11
 2 drms =      ++
                 sin C     A B
   sin2 ()sin2 ()  2 2


2 r      Cos C0.5
(G-1)
   A  B
    sin      ()sin()
   2              2
```

where:
A, B, C=angles defined in Figure G
1,
r=correlation coefficient between the measured TDs, generally taken to be 0.5,
K =bseline gradient, 491.62 ft/usec, and
s=common value for the standard deviation of each TD, generally taken to be 0.1 usec for accuracy calculations.

Referring to Figure G
1, angle A is the angle between the first secondary and the master station (viewed from the users position) and angle B is that subtended by the master and the other secondary. The actual TDs are shown by the dashed lines which are bisectors of angles A and B. The crossing angle, C, for the three station fix is:

C = A/2 + B/2.(G-2)

The parameter r in equation (G
1) is the correlation coefficient between the two TDs. The three individual signals from the master and two secondaries are assumed to be independent and uncorrelated because the timing of each signal is derived from separate cesium oscillators. However, the two TDs are correlated to some degree because both are based upon a common master signal. The correlation coefficient varies throughout the coverage area, but is typically given the value 0.5 in chain coverage calculations.

Numerical Examples

In the illustration, angle A is approximately 89 degrees, and angle B is approximately 70 degrees and angle C = 89/2 + 70/2 = 79.5 degrees. Because the crossing angle is quite large, it is to be expected that the value of 2 drms at this location in the coverage area would be relatively small. This conjecture is shown to be correct: substitution of these angles and other constants given results in a value of 2 drms of approximately 235 ftquite accurate indeed.

If the vessel (or aircraft) in the illustration were to move away from the master in a generally northeast direction until angle B were 20 degrees and angle A were 30 degrees (thus, angle C = 25 degrees), then the value of 2 drms would increase to approximately 1,922 ft.

Equation (G
1) can be used to calculate 2 drms for a three-station loran fix anywhere
within the coverage area. Table G
1 shows how 2 drms varies with angles A and B. This quantity grows quite large
whenever either or both of these angles are small. Figure G
2 shows contours of equal value of 2 drms. In general, as shown in Figure G
2, the value of 2 drms is a function of the placement of the master and
secondary stations, the users location relative to these stations, and the
common standard deviation of the TDs.

According to Swanson (1978), the greatest possible accuracy (minimum value of 2
drms) will occur with four stations, each subtending a 90 degree angle with the
adjacent station so as to form two orthogonal (at right angles) and
uncorrelated LOPs. The optimal accuracy for this configuration, 2 drms*, is
given by the equation:

given the assumed alues for each of these parameters.

The geometric dilution of position (GDOP) is defined as the ratio of the actual
value of 2 drms corresponding to equation (G
1) divided by this
best value, or:

In essence, GDOP measures the ratio of the actual value of 2 drms corresponding
to the users location in the coverage area of a loran triad to the best
possible accuracy of the best possible loran stations. GDOP is a normalized 2
drms, which takes into account the effects of the system geometry and the users
location. Table G